Reconstruction of High Resolution Images Using Deeping Learning

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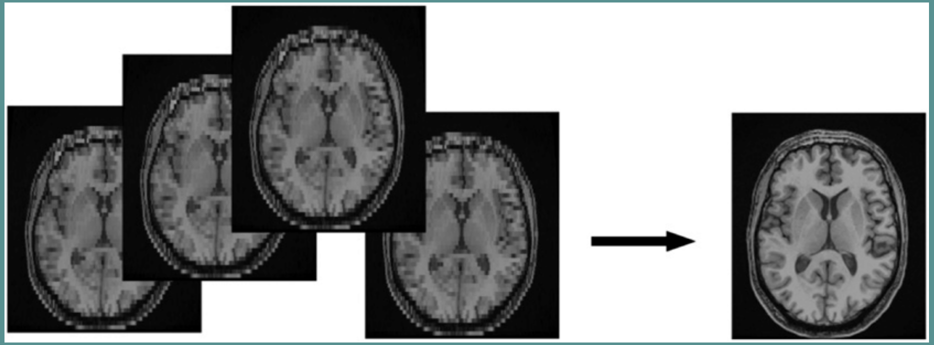
Background

- In the field of digital image processing, High-resolution images or videos are commonly needed; but in many cases, people could only obtain low-resolution images.
- Image Super Resolution is a class of techniques that turn a low-resolution image into a high-resolution one for further analysis and processing.
- High-resolution images can provide more information for human interpretation, and improve the quality of automatic machine processing.

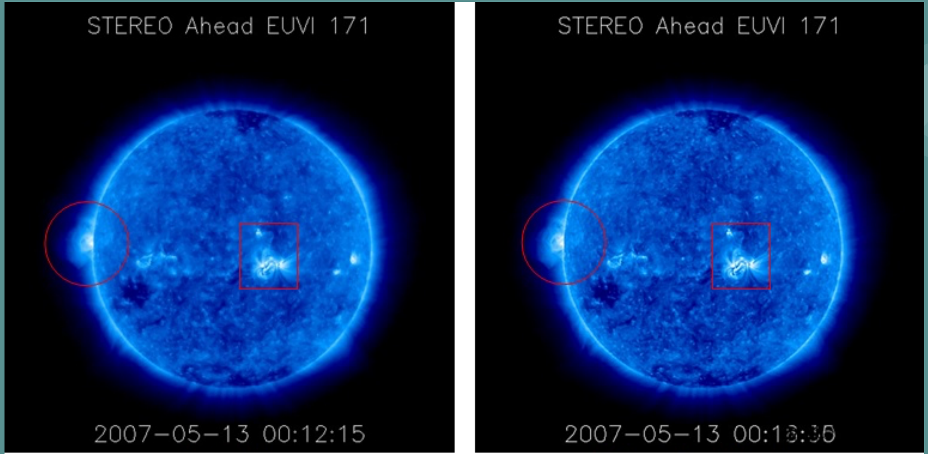
Applications

Medical diagnosis



surveillance

Applications



a. Original image b. Super-Resolution image

Regular video super-resolution

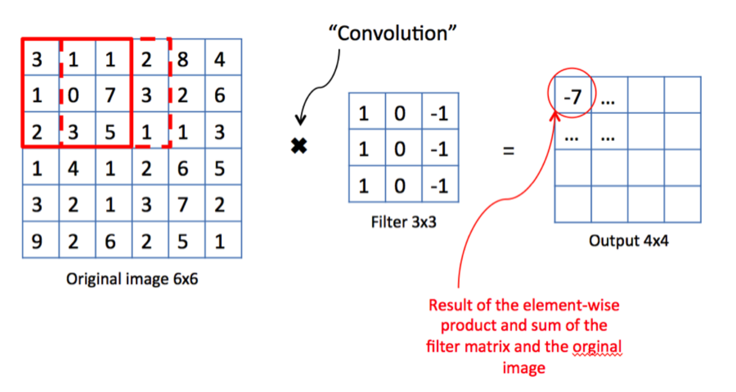
Astronomy photo super-resolution

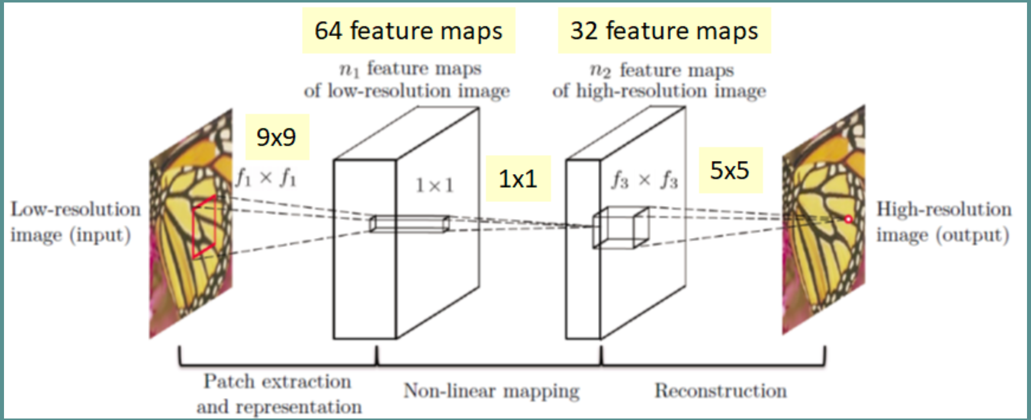
Objective and Steps

- Test and compare current deep-learning based super-resolution (SR) models, including single-image SR models and video SR models.
- Improve current SR models using the method of transfer learning.
- Implement our model on Magma DNN

Key Point -- Convolutional Neural Network

Convolutional Neural Network (CNN) is similar to ordinary neural networks. But the inputs of CNN are images, which enable us to encode certain properties into the architecture. In CNN, we add a particular type of layer, called convolutional layer, to extract features of images.





Key Point -- Transfer Learning

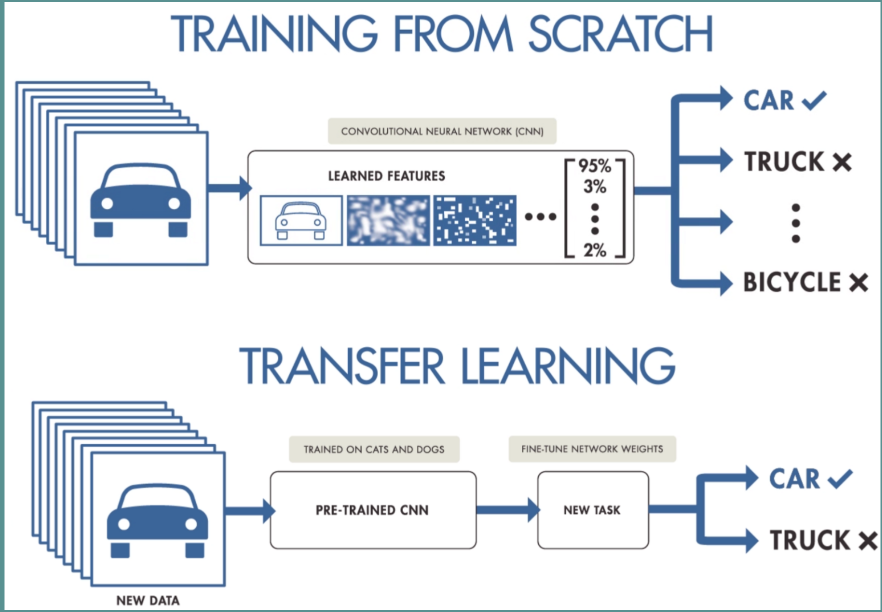
Drawbacks of training an entire neural network:

Sometimes difficult to obtain a dataset of sufficient size;

Training an entire network on a large data set is very time-consuming, sometimes takes even several weeks.

Important fact:

Pretrained neural network on a large dataset is usually a good feature extractor, thus can be reused in similar tasks.



Models

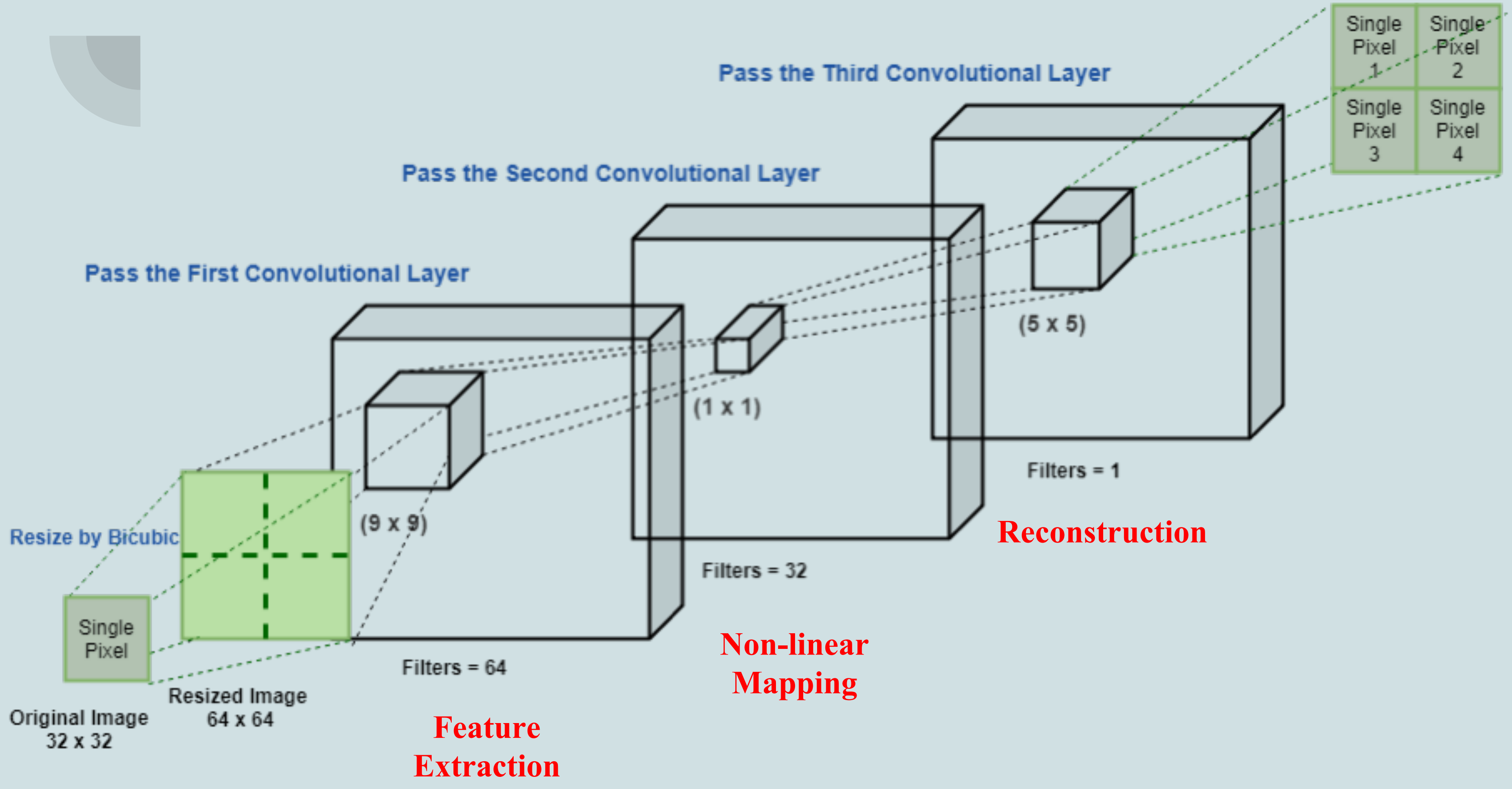
SRCNN model -- for single-image Super-Resolution

Transfer Learning --fine-tuned parameter + self-trained layers

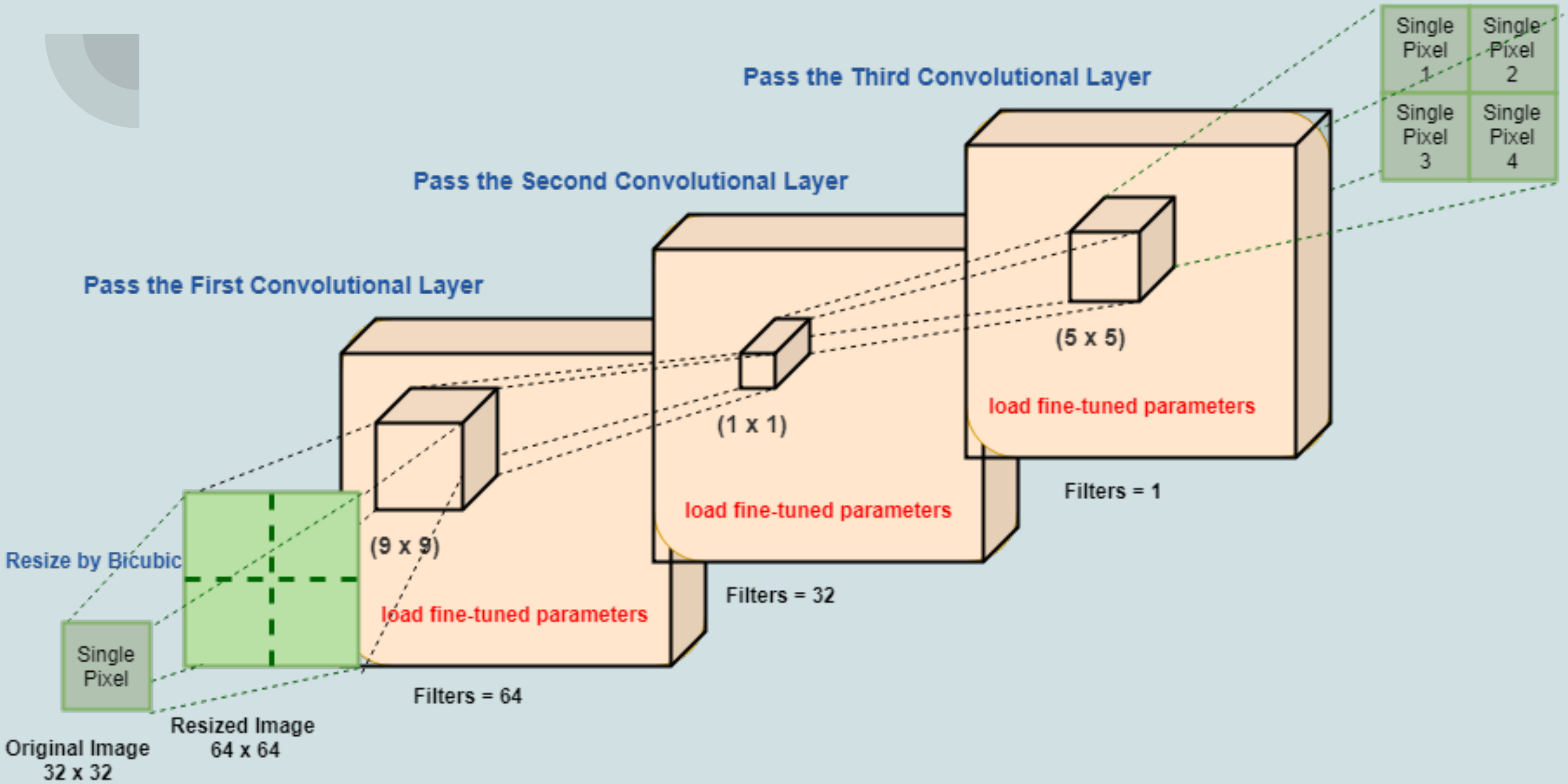
3D SRnet model -- for video Super-Resolution

Transfer Learning --fine-tuned parameter + 3D SRnet

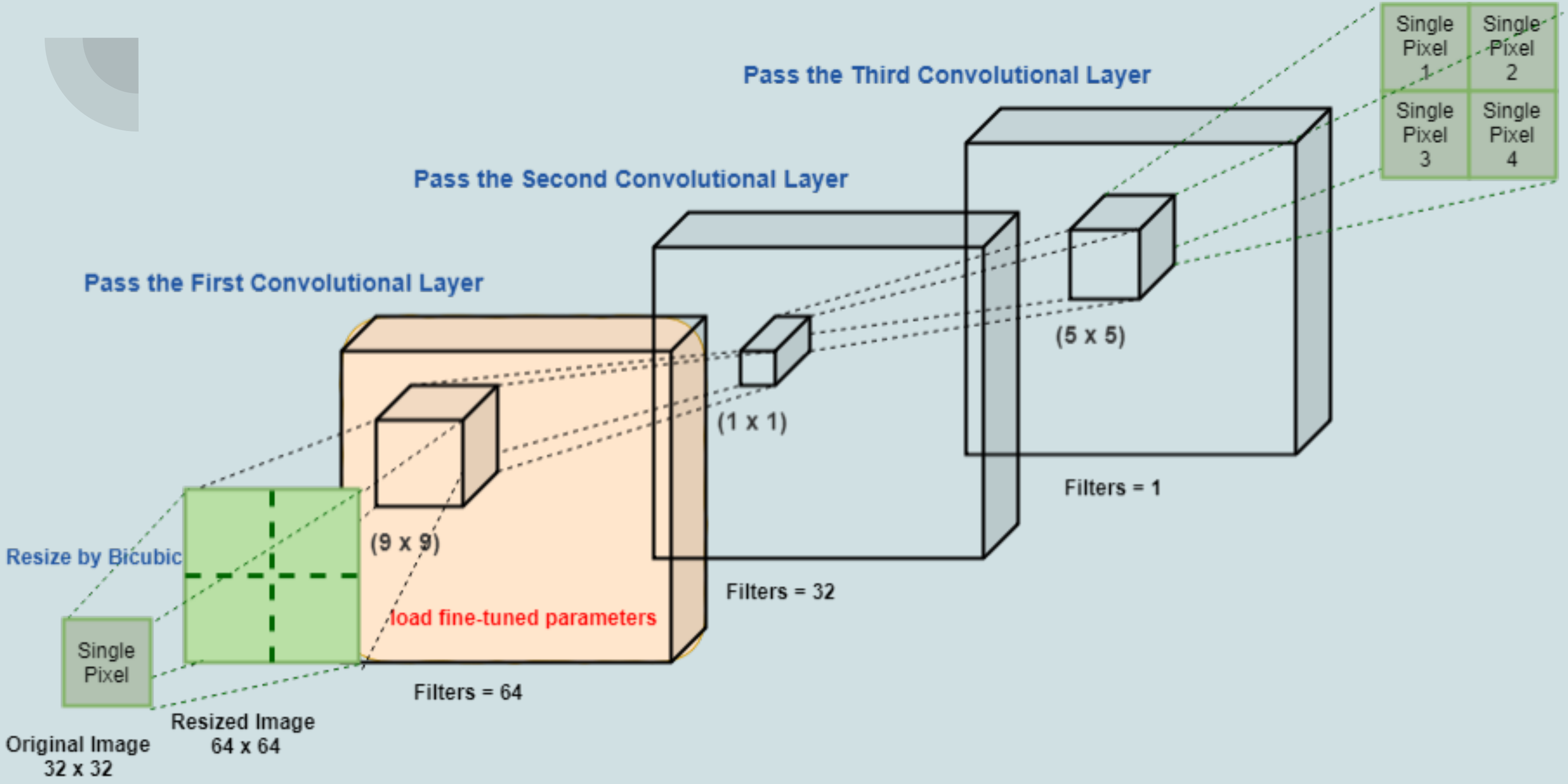
SRCNN model -- for single-image SR



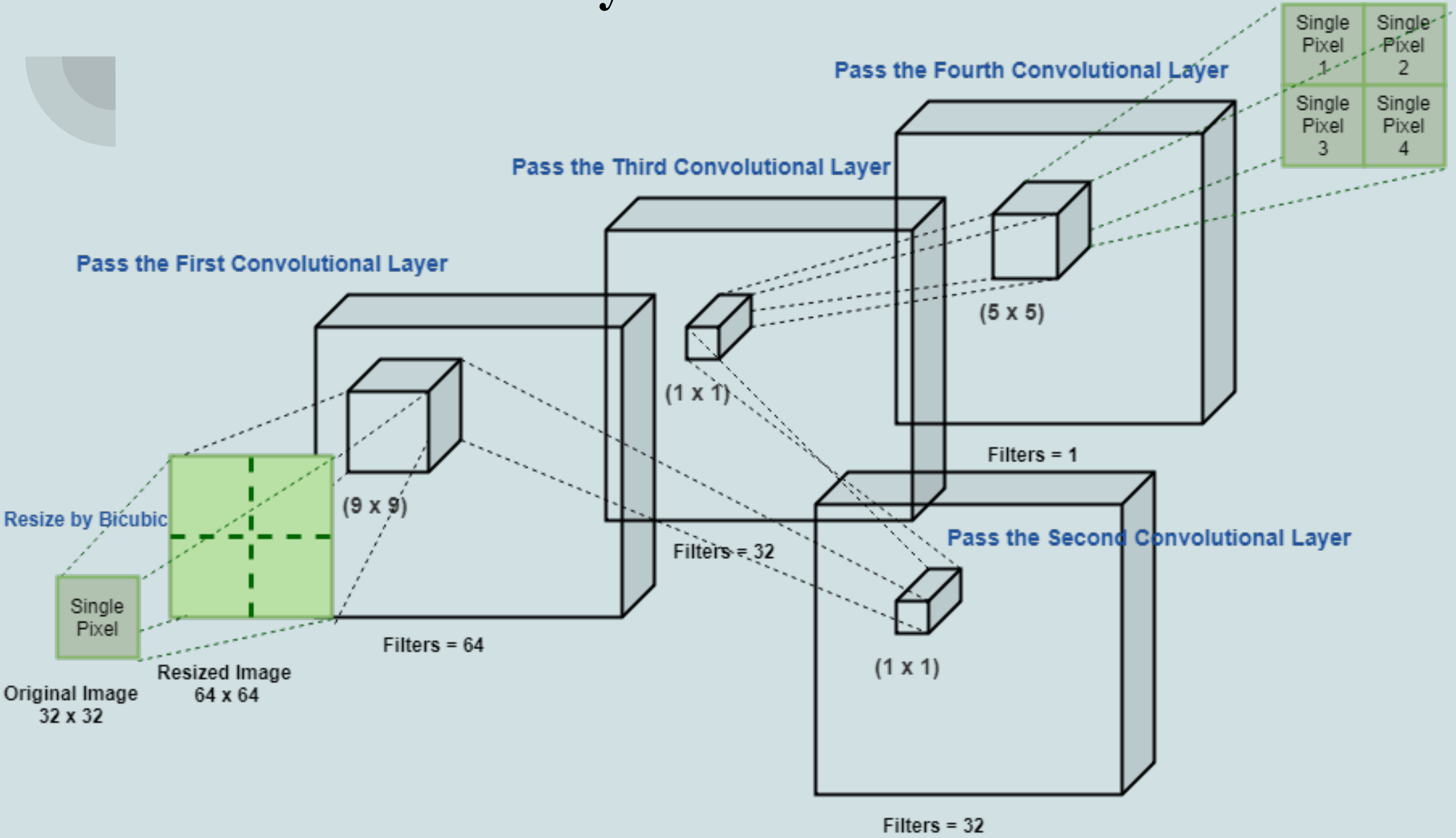
SRCNN model -- with fine-tuned parameters



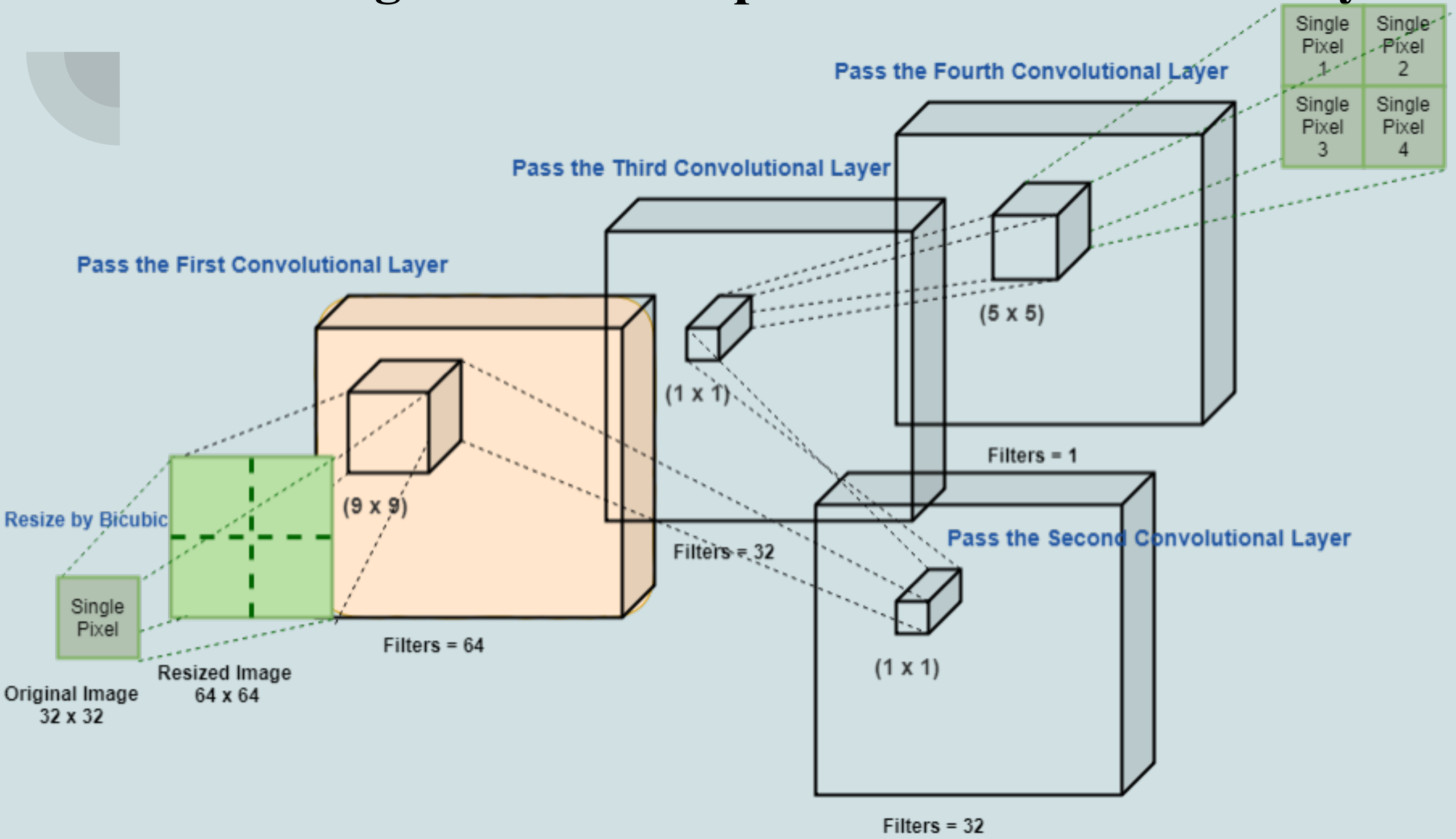
Transfer Learning --fine-tuned parameter + self-trained layers



SRCNN -- add non-linearity



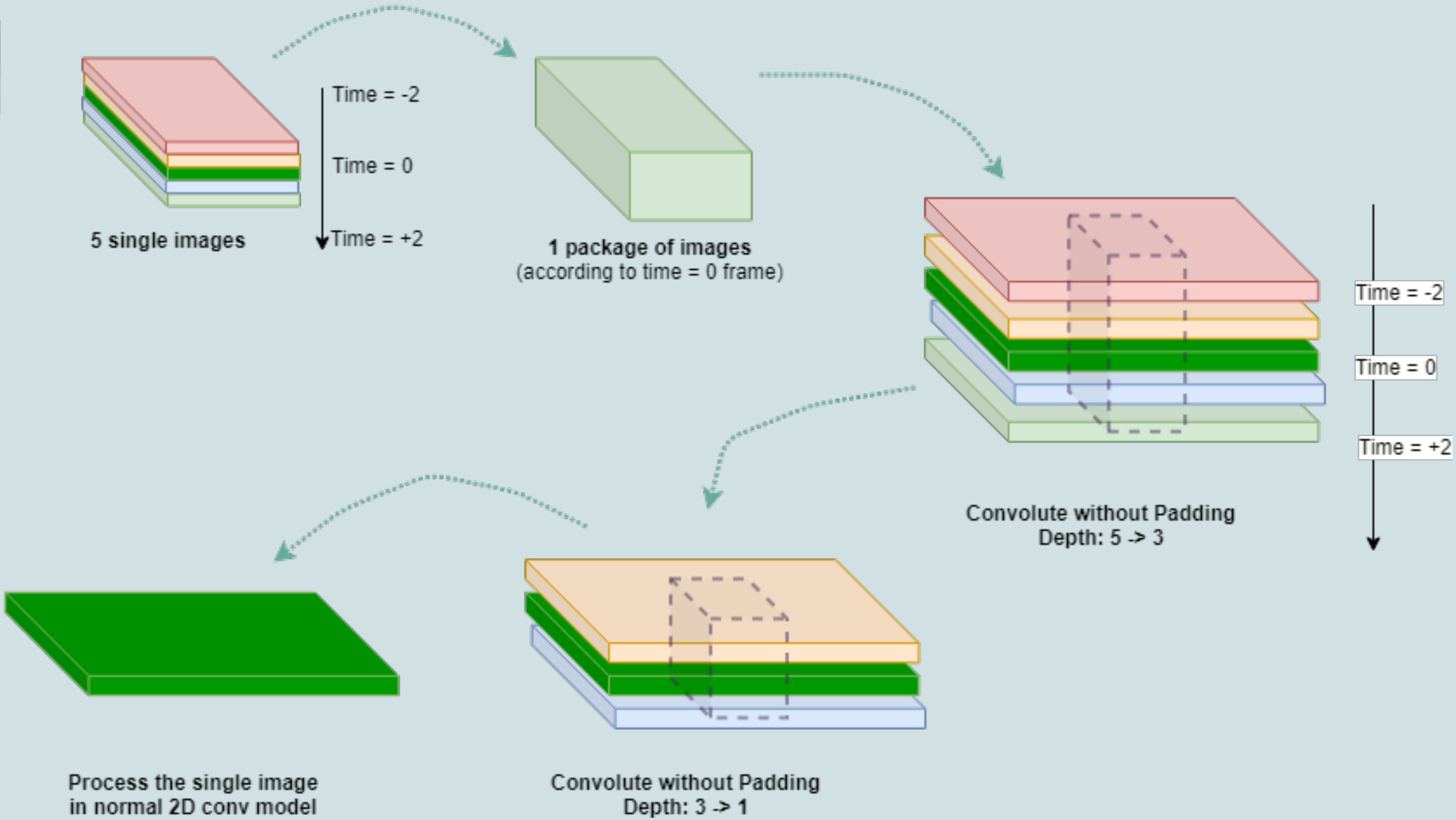
Transfer Learning --fine-tuned parameter + non-linearity



Performance

	Raw Data	Self-Trained SRCNN model	SRCNN model with fine-tuned parameters	SRCNN with transfer-learning (1+2) model	Self-trained SRCNN with added non-linearity	SRCNN with transfer-learning (1+3) model
PSNR (Peak signal-to-noise ratio)	33.246098132242 99	33.9774122589296	34.39533863298893	34.568111435612344	31.75340039322545	34.420866851485926
SSIM (structural similarity index)	0.91219161971856 61	0.9298915633331887	0.9314247043105195	0.9339550069793681	0.9276398336420119	0.9340359732007651
MAE (Mean Absolute Error)	0.016739558613043767	0.01597587670676589	0.015128582491306834	0.014882425023144312	0.021569695539644516	0.015250577526577434
MSE (Mean Squared Error)	0.0009313933013429778	0.0007675648953920149	0.0007203916113815921	0.0006896958805634528	0.0009799421850334928	0.0007280809308989662

3D SRnet model -- for video SR

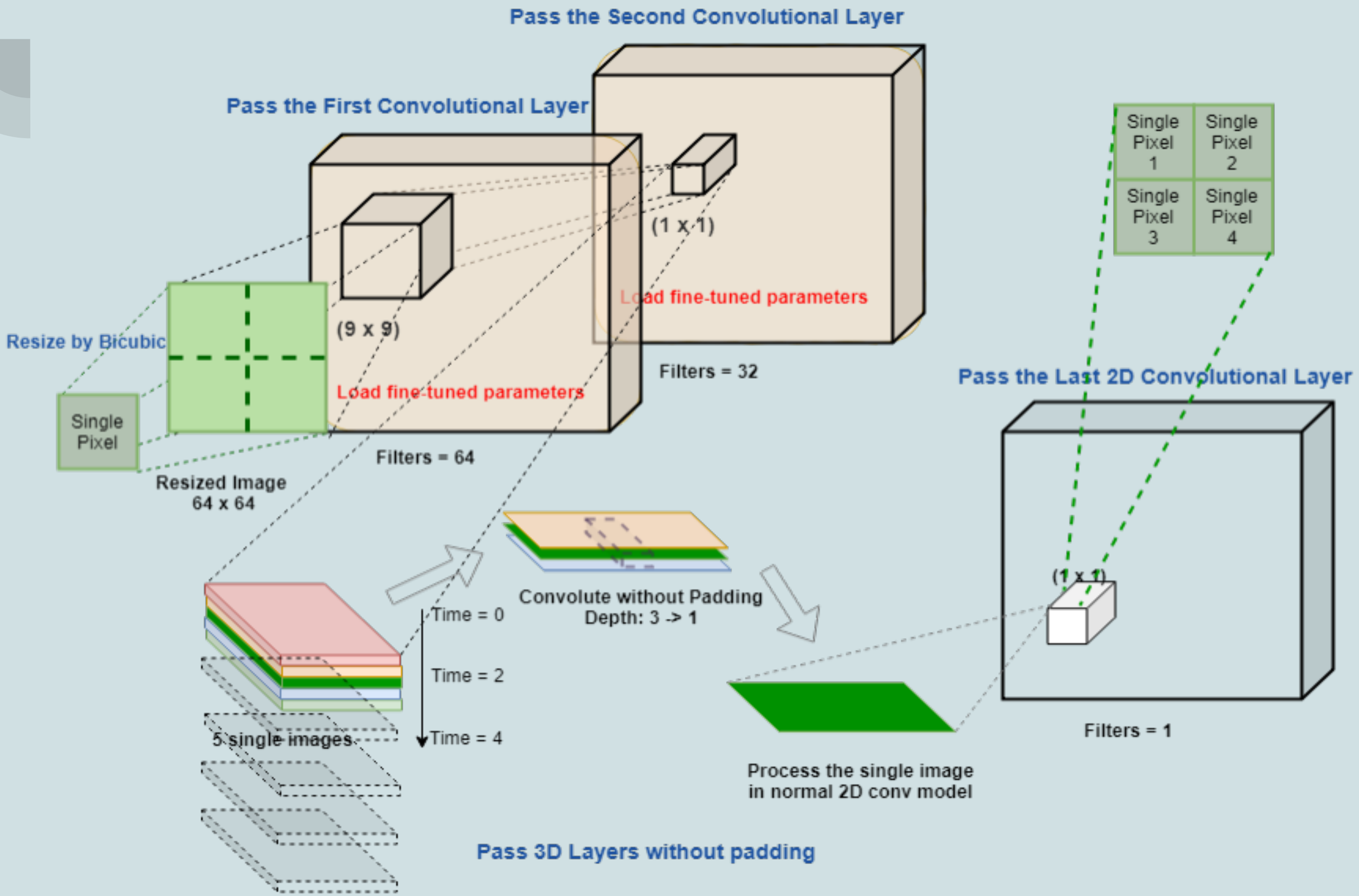


3D SRnet --for sequential images

Layer (type)	Output Shape	Param #	
conv3d_1 (Conv3D)	(None, 5, 64, 64, 32)	896	With Padding
conv3d_2 (Conv3D)	(None, 5, 64, 64, 32)	27680	With Padding
conv3d_3 (Conv3D)	(None, 5, 64, 64, 32)	27680	With Padding
conv3d_4 (Conv3D)	(None, 3, 62, 62, 32)	27680	Without Padding
conv3d_5 (Conv3D)	(None, 1, 60, 60, 32)	27680	Without Padding
reshape_1 (Reshape)	(None, 60, 60, 32)	0	Reshape for 2d model
conv2d_1 (Conv2D)	(None, 60, 60, 1)	1156	With Padding

Total params: 112,772

Transfer Learning --fine-tuned parameter + 3D SRnet



Conclusion

Pre-process dataset;
Build and test typical models;
Combine typical models by using transfer learning.

Implement transfer learning with 3D Model;
Use different dataset;
Fine tune hyper-parameters.
Try MagmaDNN for implementation.

Reference

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Q & A